RESEARCH AT UNIVERSITIES IN BRITISH COLUMBIA

A Discussion Paper
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by

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PREAMBLE

This brief discussion paper is about research at universities in British Columbia. It begins by saying some general things about research, follows with some remarks about sectoral research activity in Canada and in British Columbia, and then focusses on research at universities and who uses the results. Some concluding remarks suggest some directions for the future.

A BIT ABOUT RESEARCH IN GENERAL

When most people speak of doing research, they mean that they are trying to find out something they didn't know before. At a university, to do research is to try to find out something that nobody knew before. It's a search for what is not known that may lead to the discovery of new facts and insights. The results are frequently unexpected and sometimes astonishing. The process of research is only complete when the discoveries are added to the store of human knowledge by being published, patented or otherwise made available for the world to share.

There is always much fuss about whether research is "pure" or "applied", "mission-oriented" or "motivated by curiosity", or whether it is "relevant".

It is fairly easy to judge relevance in wholesale terms such as "why are we doing so much research on subject X as opposed to subject Y"; virtually all research funding agencies make judgments on that kind of question. So do all kinds of researchers. Much more difficult is to decide whether this or that approach to a particular problem is likely to pay off. The stereotype of the applied researcher is one who takes existing know-how, adds a few new wrinkles, and builds a better mousetrap while the "pure" or "basic" researcher discovers new things about mice that make mousetraps obsolete.

Which kind of research to encourage is much like asking what kind of investments to make. Some look pretty likely to pay off, at least with small dividends, and in the event most do, but some don't. Others look chancey but could pay off handsomely, and most don't, but some do. The lessons to be learned from the history of research are that research isn't very predictable and it pays to spread your risks.

If kinds of research are to be labelled, the best distinction to make is between good research and poor research. That which is well done and will not have to be done again is what professional researchers call good research, whether it is concerned with black holes in the far reaches of space or the development of a new and better variety of apples. Good

research is also that which poses many new questions, opening whole new fields of enquiry or new avenues for development.

Many kinds of research can only be done if there is some wherewithal. You can't measure radioactivity without a Geiger counter. You can't count bacteria without a microscope. You can't study history without a library. For much of modern-day research, expensive facilities are an essential prerequisite and this year's facilities may not be sufficient for next year's research. New discoveries lead to new ways of doing things and only those who can master the new way can continue to participate.

Some kinds of research require special large scale facilities or settings. Anthropologists need museums, particle physicists use cyclotrons, clinical researchers in medicine work in hospitals. It is no accident that research is commonly concentrated around major research facilities. Virtually all research depends on the presence of large up-to-date libraries. How else to find out what is known? In the last two decades, computers have become essential for many kinds of research involving large amounts of information or calculation. The forecasting of the economy or the weather are good examples.

It isn't easy to generalize about all of the needs for all of the kinds of research, for they are as broad and diverse as

the whole of human knowledge. It is often said that scientists need laboratories and equipment, while those in the humanities need books. That's too simple. Scientists also need books, and for many humanists and social scientists travel is the essential counterpart of a laboratory.

Research thrives best when it is appreciated. It often prospers only when it is done in a place where lots of research is being done. The opportunity to talk with other investigators is a major factor influencing where young people are attracted for careers in research. What makes the great research centres of the world what they are is their large number of good researchers and their excellent facilities. It follows that in building a research enterprise it helps a great deal to start with what is usually called "a critical mass." After that, further growth is according to the adage: "Nothing succeeds like success."

SOME REMARKS ABOUT RESEARCH IN CANADA AND IN BRITISH COLUMBIA

Governments have long recognized the important role of research in their future. In the latter part of the 18th Century it was the potential value of science to the national economy that prompted Royal patronage of university professor-

ships.[1] It was seen then as it is today--that if you don't do research, you are not plugged in to what is being discovered elsewhere that may shape your future. The crucial difference between the developed and the underdeveloped countries is who sends consultants to whom. (Would the government of British Columbia hire consultants from a provincial university in Nigeria?) While Canada does only about two per cent of the world's research and the world would never miss us if we quit, that two per cent plugs us in to all the rest and makes us purveyors rather than purchasers of knowledge.

Whether we are doing enough research to hold our own culturally and economically is doubtful. Canadian research and development expenditures, where research and development is taken to include the humanities, are still on a scale with the countries that are only marginally called "developed." While we might think our research is better on the average than that of other countries, we have to remember that there is no evidence that we are any smarter on the average than anybody else.

With respect to how much of the research is done in various sectors, Canada differs from many other developed countries in

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[1] Smeaton, William A. 1984. Torbern Olaf Bergman: from natural history to quantitative chemistry. Endeavour, New Science 8(2):71-74.

having a greater proportion in federal government and universities and less in the private sector. For example, in the United Kingdom in 1978, the private sector contributed over 60% of the total R&D expenditure[2]. In the United States, 60% of the personnel in scientific R&D is in industry.[3]

Statistics concerning who does research in Canada may tell a quite misleading story about research. Those listed by Statistics Canada as scientific and professional may be largely engaged in administration related to research, or in professional routines that aren't directed to discovery or development Even within government laboratories, such as those of the National Research Council or within provincial research councils those working on research even part time may be a small proportion of the total. These people are nevertheless reported as full time, while all university personnel are considered to be engaged in "research or development" for only 30% of their time ("natural sciences"), or 20% ("social sciences and humanities").

With those reservations in mind, it is useful to note that in 1981 the private sector accounted for 48% of the "person

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[2] Bowles, J.R. 1983. Research and development: preliminary estimates of expenditure in the United Kingdom in 1981. Economic Trends. Central Statistical Office, Government Statistical Service, 359:108-117.

[3] National Science Foundation. 1983. Science and Engineering Personnel: A national overview. NSF 82-318.

years" of "scientists and professionals" in Canada; the federal government, 20%; and the universities, 26% (Table 1). Doctored as they are, these statistics still underline that Canada has a relatively undeveloped private sector research activity.

The statistics for British Columbia tell a similar story. (Table 2). Industry accounts for less than 16% of personnel, the federal government for 10%, and universities for over 70%! Despite a substantial growth in international consulting and small high technology companies, the B.C. industrial research sector is still small and researchers number less than 1000. The total cadre of federal government researchers in British Columbia is less than 500. The provincial government research complement is less than 200.

The three universities have a total of over 3000 faculty members, all of whom are expected to do research. Also, as part of their responsibilities, the professors supervise the research done by graduate students (apprentice researchers) and though only about one-half of the 6500 British Columbia graduate students are in research-oriented programs (the other half are in professional graduate programs), they represent a formidable research force (Table 3). When the postdoctoral fellows and the research associates are added in (together about 300), the total research manpower at the three universities is without question the most significant research element in British Columbia today.

TABLE 1. Research and Development Personnel, by Sector, in Canada in 1981.[4]

	Scientists & Engineers		Researchers & Professionals Social Sciences & Humanities
Federal Government	5350		370
Provincial Governments	830		370
Business/Industry	-	13,810	-
Universities (faculty only)	4150		3370
Non-profit enterprises	-	280	-
TOTAL		28,530	

[4]Canadian Science Indicators 1983. Statistics Canada, Ottawa.

TABLE 2. Personnel engaged in scientific and professional activities in British Columbia and Canada, 1981. Statistics provided by Science Council of B.C.; Canada-wide statistics from Statistics Canada.

	Scientific & Professional	Technical and Other	Total
Industry			
British Columbia	700	705	1,405
Canada	13,810	16,820	30,630
Federal Government			
British Columbia	462	1,211	1,673
Canada			24,452
Provincial Government			
British Columbia	166	183	349
All provinces summed			2,700
Universities			
British Columbia	3,163	-	-
Canada	33,000	-	-

TABLE 3. Numbers of graduate students enrolled in various degree programs at British Columbia universities.

	UVIC	SFU	UBC	TOTAL
Research Thesis Usual				
Ed.D.) Doctoral) D.M.A.)	113	290	1006	1409
M.Sc.) M.A.Sc.)	87	155	987	1229
M.A.	317	292	736	1345
Professional Programs				
M.B.A.	181	148	383	712
M.Ed.	361	340	525	1226
Other	58	183	383	624
TOTALS	1117	1408	4020	6545

RESEARCH AT UNIVERSITIES IN GENERAL AND AT THOSE IN BRITISH COLUMBIA IN PARTICULAR

Research is done at universities as an integral part of education. Students pay fees to hear professors who know what they are talking about. To know what they are talking about, professors must know their subjects thoroughly and be well read on the latest literature. One of the best ways of ensuring that professors are up to scratch is to require that they do research and have it published in journals that are refereed by their scholarly peers. If that test can be met, it must mean that the professors have discovered things nobody knew, which implies that the professors knew all that already was to be known--at least on their special subjects.

Several things flow from this basic rationale for research at universities. Whether an aspiring young assistant professor receives tenure (and only after six years of service) largely depends on research productivity. Many don't receive tenure (or quit before it is denied them). For those who do receive tenure, subsequent promotion to Associate or Full Professor rank and merit increases in salary also hinge largely on research publications.

Young professors learn quickly to acquire a great deal of knowledge about a specific topic. As they mature and accumulate

experience, their range of competence gradually broadens, but by layman's standards most young professors are very narrow specialists. It is increasingly typical of contemporary research that it is very highly specialized, loaded with highly technical terminology and presented either orally or in print in an extremely compact and formal manner that assumes a great deal of knowledge on the part of the audience (did you know that alpha-D-Glucopyranoside beta-D-fructofuranosyl is just plain sugar?) It should come as no surprise that most scholarly works are perused by only a handful of readers. The world congress of Plecoptera (stone fly) systematists (pigeon holers) in 1975 had a total attendance of only 13 (the other one was sick!). But it is this very specialization that is essential in most fields of research. The explosion of knowledge in recent decades has inevitably meant that for those who are expected to "know it all", it is unrealistic to try to cover too wide a field.

A recent detailed study of a selected group of Canadian universities concluded that professors receive 26% of their salary for doing research.[5] That's probably a fair enough estimate during a five day working week because preparing and giving lectures and tutorials, and supervising laboratories and

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[5]Canadian Association of University Business Officers, 1982. Report of the study on he costs of university research. 89pp.

the usual chores of administration, are time consuming. But for most professors, research is a way of life and an endless source of exhilaration. Adding up all of the late hours and weekends on research and the related necessities of evaluating the works of others and attending conferences and so on would suggest that most professors give far more than 26% of their total year to research. Perhaps the most crass way to express it is to say that by providing 26% of a professor's salary nominally for research, the university (and the taxpayer) gets more than 26% of a professor's time.

The lion's share of the financial wherewithal for equipment and the technicians for research comes from the federal government in the form of grants from the national granting councils. Most of the grants are awarded on the basis of national competitions in which the proposals judged best by peers are the ones that are funded. Grants are also obtained from provincial government agencies, non-profit organizations, and from internal research competitions.

The total expenditure on research at the three provincial universities in 1983/84 was over $60 million (Table 4) mostly in the form of relatively small amounts for projects to be undertaken by individual professors with the assistance of one or two graduate students. Indeed, the number of graduate students a professor supervises depends on the grants and contracts that

TABLE 4. Funding of Research at British Columbia Universities, 1983/84.

	UVIC	SFU	UBC	TOTAL
GRANTS				
Federal	3,926,616	5,315,428	29,428,853	38,670,897
Provincial	162,516	511,801	4,125,499	4,799,816
Other	158,165	301,491	9,933,775	10,393,431
Internal	441,320	423,988	198,915	1,064,223
Total Grants	4,688,617	6,552,708	43,687,042	54,928,367
CONTRACTS				
Federal	762,681	765,838	3,946,830	5,475,349
Provincial	30,251	-	546,896	577,147
Industrial) & Other)	66,608	55,612	691,724	813,944
Total Contracts	859,540	821,450	5,185,450	6,866,440
TOTALS	5,548,157	7,374,158	48,872,492	61,794,807

are won, which in turn depend on how much research of high quality the professor has previously produced, which depends in large part on how much grant and contract funding was previously received. In total, grants exceed contracts as sources of research funding, though in recent years there has been a substantial increase in contract funding, particularly from the federal government. By comparison with universities in other parts of Canada, B. C. universities fare very well in the national granting competitions. In contracting, we do less than universities in Ontario and Quebec.

It is characteristic of much university research that it is broken up into what are often called "thesis sized lumps." Although a professor's work may continue for a decade or two (or more) a student must do a research project demonstrating a capacity for research and then move on. For this reason, some kinds of research are not as readily done at universities as at other kinds of institutions, unless there is provision for research associates and technicians who can stay with a project over many years. Long term resource management research studies in forestry, agriculture and fisheries, for example, are often attempted in collaboration with government laboratories. The same is true of other kinds of largescale multi-disciplinary applied projects.

Such generalizations must be taken with a grain of salt because universities may be very different from each other in what they will attempt and what they can achieve. Some, for example, take pride in teaching undergraduates, and while the values of scholarly activity are appreciated, the institution may not have research productivity as a prime criterion for judging merit. Others are dedicated to teaching and research in particular applied subject areas: the various polytechnic universities of the world are prime examples. Still others take special pride in involvement in internationally oriented activities, especially toward developing countries. There are many other ways in which universities build their character around one or more of the dimensions of higher education.

Universities also differ in their maturity. Many North American universities were launched more or less as polytechnic institutions designed to serve the agricultural and engineering enterprises that characterized a young growing society. The emphasis was on applied research (better breeding of livestock, design of irrigation canals, highway engineering, and so on) that drew heavily on the accumulated experience of European institutions. With growth and diversification and greater sophistication, North American universities became more mature educational enterprises, training a wider range of professionals and contributing a proper share to the common fund of knowledge.

The British Columbia experience is fairly typical and the province's three universities are now major components of a responsive system for higher education and significant contributors to the national research effort. In terms of maturity, one might say that British Columbia universities have just got over their adolescence and have barely begun to make the research contributions of which they are capable. A single contrast makes the point. The three British Columbia universities together have 6500 graduate students and a total research funding of about $60 million. The University of Washington has 7258 graduate students, only a few more than we do, but a research funding of $171 million (and that's U.S. dollars!). We obviously have a way to go. For the current year, University of Washington research funding is up 19% and the year end total, when reported, will be about $204 million.)

The comparison is not quite what it seems. In the United States, there are charges for faculty time on grants and contracts; as well, overhead charges which are levied on both grants and contracts are higher than in Canada. If appropriate adjustments are made, the research funding at the University of Washington is less than twice that of the three British Columbia universities. But we still have a way to go to equal their research activity.

A major reason for the difference in research funding between United States and Canadian universities is the involvement in contractual research. They are approached to do much more contracting than we do; their overhead rates are higher; but, most to the point, government and industry have a long standing practice of close collaboration with universities. There has evolved from this practice a considerable operational experience which Canadian universities are currently trying to assimilate and, where appropriate, to emulate. It isn't easy because Canada doesn't have the same industrial research base and the federal government, anxious to build private sector research, specifically excludes universities from its contracting out policy.

WHO USES THE RESEARCH DONE AT BRITISH COLUMBIA UNIVERSITIES?

Aside from the students who get the research news first as part of their education, the prime users of the research done at the three provincial universities are, in order, the world at large, the federal government, industry and the provincial government.

Much of the research that is done at the universities is published openly as new knowledge from which all may benefit as they will. The other side of the coin is that the three

universities have the access and the knowhow to exploit whatever is published by everyone else in the world. It's a good deal for us.

The second user is the federal government. Almost any week of the year there is a good sized handful of British Columbia university professors in Ottawa, or somewhere else in Canada, on federal government business. They are on an endless succession of advisory boards, committees, royal commissions, task forces, working groups and solo consultations. The federal government public service mandarins have long since learned that there are two things to be gained by asking university professors for advice. Second, is the quality of their advice, which can be ignored or followed as seems appropriate. First, is the capturing of their interest in problems that concern the federal government. It is in consequence of a long established tradition of inviting professors to give their advice that the federal government has attracted their scholarly attention to matters of national interest.

Industry, though a bit prone to go east or south for advice, has come on in recent years as a strong user of the local universities as resources. Through a variety of mechanisms including consultancies, liaison committees, joint ventures, cooperative programs, research contracts, "retraining" programs and involvement with graduate students, industry links

with universities are both active and expanding. Many university departments currently do more contractual research for American than Canadian companies and with more eastern Canadian than British Columbia companies, which may be evidence that our researchers are first class and widely known, but which may also indicate that our local industry is somewhat sleepy. The universities can do more for the local industry than they are being asked to do.

The provincial government, although it provides the core budget for higher education, has been the least consistent user of university resources. In consequence, many opportunities to interest researchers in problems that concern the British Columbia government have been lost. To be most blunt, the provincial government may not get its money's worth out of its university professors because it doesn't make use of them to the degree it could. It would be useful for the Universities Council of British Columbia to take some appropriate initiatives, such as encouraging the various line departments of the provincial government to make more systematic use of university capabilities and enlarging the current granting, contracting and contributions programs to support research at the universities.

It is appreciated that the province provides the basic physical facilities, the operating costs and the salaries of the faculty and staff, and that should perhaps be considered enough.

But that's like planting an orchard and only using the trees for shade because you don't want to buy a ladder to pick the fruit.

WHERE DO WE GO FROM HERE?

In a nutshell, with respect to research, Canada is marginally within the developed countries of the world and in the future should expand research, especially in the private sector. The same is even more true of British Columbia where research is largely concentrated in the universities, and where it is not exploited as effectively as it could in the cultural and economic development of the province.

None of this should be taken as bad news, but rather as indicative of a stage of development in which the various societal sectors of government, industry and university have been busy doing their own growing and are only now developing ways in which they might more actively collaborate in the future. At each of the three provincial universities a lot of attention is currently being given to liaison with industry and government. This is a healthy development and from the research point of view should be mutually rewarding.

Much of what is happening now at the universities was foreseen as being desirable and promoted both by the Gaudry

report[6] of 1976 and in the mission statements prepared in 1978 by the universities for The Universities Council. The President of Simon Fraser University literally underlined the message that "...this University must come to be regarded as a provincial resource" and emphasized that "the universities, UCBC, government, the private sector--must make the effort needed to achieve that goal." There were similar remarks in the University of Victoria and the University of British Columbia statements, in the latter case coupled with the setting of targets of 6000 graduate students and research funding of $50 million ($78 million in 83/84 dollars). Evidently, the three universities are going in the directions they had indicated that they thought they should go.

It will be important, though, that the universities not go overboard in getting so much involved with the immediate concerns and research needs of industry and government that students are not given the attention they need nor the kind of education that will give them a lasting capability. There are many universities in various countries that have focussed too narrowly on immediate social concerns. Their students get the type of training that makes them employable upon graduation in a particular role, but in only a few years leaves them

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[6] Gaudry, Roger. 1976. The state of research and research funding in British Columbia. 44pp + appendices.

obsolete in that role and unemployable in other roles. Universities of that kind in the long run achieve little distinction either through their faculty or alumni. It simply doesn't pay society to have university research priorities set by the immediate requirements of outside agencies.

While this is not a problem with provincial government or industry funding at the present time, it is worth remark that university research priorities may already be influenced more than is desirable by federal government initiatives. Increasingly, it is the trend that funds are made available for this or that particular kind of research provided the university shows its eagerness by picking up part of the expense or by picking up all of the expense after a certain number of years. If a university becomes too mesmerized by the dollars, it may find after a dozen years or so that it has a stable of professors in fields no longer of interest to students (or government or industry). In more ways than one, the university often can't afford to participate in federal government initiatives.

It is also important that British Columbia industry and the British Columbia government should develop their own research competence. Industry needs researchers who can singlemindedly address themselves to industry problems and follow discoveries

through to their commercial prototype production. Government needs researchers to focus on problems of both short term and long term significance to provincial development. From the university point of view, it is far easier to "make a connection" through the research arm of a corporation or government department.

There are no simple recipes to follow in deciding how much research should be done and what proportion should be done in universities, in industry or in government agencies. There also are no simple recipes for how much to spend on basic as opposed to applied research or how much on natural sciences as opposed to social sciences and the humanities. Judging by what has transpired in the past 20 years, those who have invested the most have fared the best. The countries of the world are in the midst of what has been called a technological Olympics with all that is implied for national economies and entrained social and cultural consequences. It will be very important for British Columbia and for the provincial universities in particular to maintain a strong research competence in the years to come.